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(54) SEMICONDUCTOR DEVICE AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method for manufacturing a semiconductor device by which a CSP of a wafer level package type having a small warpage after resin- sealing, excellent reliability and heat resistance with a good productivity can be easily manufactured.

SOLUTION: The method for manufacturing the semiconductor device comprises a step of heating/press bonding a polyamic acid film of a semi-cured state having a tensile elastic modulus after imide deriving of 2,000 MPa or less, a linear expansion coefficient of 200 ppm/°C or less and a glass transition temperature of 200°C or higher on the surface of a wafer-like semiconductor element having a passivation film and metal posts for electrodes of the element, a step of exposing the surfaces of the posts by heat treating the element formed with the polyamic acid film and polishing the surface of a polyimide sealing material as needed after the imide deriving is completed, a step of forming a metal bump on the exposed surface of the post, and a step of rear surface polishing and dicing the wafer in which the metal bump is formed.

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TITLE: Semiconductor devices sealed with polyamic acid films
through waferlevel packaging process

PATENT-ASSIGNEE: SUMITOMO BAKELITE CO LTD[SUMB]

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H01L023/29, H01L023/31

ABSTRACTED-PUB-NO: JP2002280494A

BASIC-ABSTRACT:

NOVELTY - A new semiconductor device comprises a sealing material layer formed on the passivation film of semiconductor elements having metal electrodes. The sealing material layer is 10-300 micron thick and is made of polyimide resin which has a tensile elasticity of up to 2.000 MPa, a linear expansion coefficient of up to 200 ppm/ deg. C, and a glass transition temperature above 200 deg. C.

*semi-cured
tensile elastic
modulus*

USE - For producing semiconductor devices with chip-scale packaging.

ADVANTAGE - Semiconductor devices less warped after sealing with resin are obtained.

CHOSEN-DRAWING: Dwg.0/0

TITLE-TERMS: SEMICONDUCTOR DEVICE SEAL POLYAMIDEACID ACID FILM THROUGH WAFER
LEVEL PACKAGE PROCESS

DERWENT-CLASS: A26 A85 L03 U11

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EPI-CODES: U11-A07; U11-A09; U11-E02A1; U11-E02A2;

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018 ; D11 D10 D18*R D19 D18 D22*RD24 D22 D25 D07 D77 D79 D41 D45
D50 D76 D94 D95 F81 F86 E34 E30 E32 E30*R ; H0293 ; H0260 ; H0077
H0044 H0011 ; P1081*R F72 D01 ; H0011*R ; P1445*R F81 Si 4A ; L9999
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Polymer Index [1.2]

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 PA Sumitomo Bakelite Co., Ltd., Japan
 SO Jpn. Kokai Tokkyo Koho, 7 pp.
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CLASS

PATENT NO.	CLASS	PATENT FAMILY CLASSIFICATION CODES
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	ICS	H01L023-31; C08G073-10; H01L021-56; H01L021-60; H01L023-12
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AB		A semiconductor device resistant to warping after sealing comprises a <u>polyimide sealing layer</u> having a <u>modulus of elasticity \leq 2000 MPa</u> , linear thermal expansion coefficient \leq 200 ppm/ $^{\circ}$ C, glass transition temperature \geq 200 $^{\circ}$ C, and a thickness 10 - 300 μ m on a passivation film over a semiconductor element with metal electrodes. A method for fabricating the above device is also described.
ST		semiconductor device fabrication polyimide sealing passivation film
IT		Polyimides, uses RL: DEV (Device component use); TEM (Technical or engineered material use); USES (Uses) (di-Me polysiloxane-; semiconductor device and semiconductor device fabrication by sealing passivation film with polyimide)
IT		Polysiloxanes, uses RL: DEV (Device component use); TEM (Technical or engineered material use); USES (Uses) (di-Me, polyimide-; semiconductor device and semiconductor device fabrication by sealing passivation film with polyimide)
IT		Passivation Sealing compositions Semiconductor devices (semiconductor device and semiconductor device fabrication by sealing passivation film with polyimide)
IT		Polyimides, uses RL: DEV (Device component use); TEM (Technical or engineered material use); USES (Uses) (semiconductor device and semiconductor device fabrication by sealing passivation film with polyimide)
IT		142468-17-5, 3,3',4,4'-Benzophenone tetracarboxylic acid dianhydride-2,2-bis(4-(4-aminophenoxy)phenyl)propane-1,3-bis(3-aminophenoxy)benzene-3,3',4,4'-biphenyltetracarboxylic acid dianhydride

* NOTICES *

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- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention protects the integrated-circuit section of a semiconductor device, and is excellent in the electrical installation stability of a semiconductor device and an external device, and relates to the semiconductor device which made high density assembly possible especially a chip scale package (CSP), and its manufacture approach.

[0002]

[Description of the Prior Art] After cutting conventionally the semiconductor integrated circuit equipment (IC) produced on the wafer for each chip as a manufacture method of CSP, installation of a bump electrode and the resin seal of IC surface protection were performed. On the other hand, the wafer level packaged air conditioning which carries out closure shaping collectively on wafer level is beginning to attract attention in recent years.

[0003] CSP by this wafer level packaged air conditioning On the wafer-like semiconductor device front face in which the passivation film and the metal post for component electrodes of a semiconductor device were formed, usually, by compression shaping or transfer molding After forming an epoxy resin system sealing agent, a polyimide sealing agent front face is ground if needed. The process at which a metal post front face is exposed, the process which makes a metal bump form in the exposed metal post front face, and the wafer in which said metal bump was formed are manufactured by taking rear-face polish and the process which carries out dicing.

[0004] However, although it originates in the difference of the coefficient of linear expansion of closure resin and a silicon wafer and curvature occurs after a resin seal, especially, with the wafer of a big diameter 8 inches or more, curvature becomes remarkable, an after process becomes difficult and the package manufactured by such approach poses a big problem on manufacture.

[0005]

[Problem(s) to be Solved by the Invention] The curvature of this invention of the package after a resin seal is small, and is to offer the semiconductor device by the wafer level packaged air conditioning which is moreover excellent in dependability, and its manufacture approach.

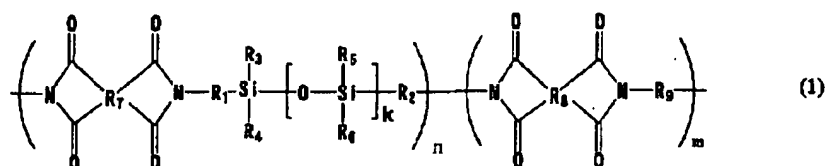
[0006]

[Means for Solving the Problem] That is, this invention is a semiconductor device with which a tension elastic modulus is characterized by forming 200 ppm [degree C] /or less and glass transition temperature by 10-300-micrometer thickness with the polyimide resin 2000 or less MPas and whose coefficient of linear expansion are 200 degrees C or more as a sealing agent layer on the semiconductor device passivation film with which the metal electrode was formed.

[0007] Moreover, polyimide resin is said semiconductor device characterized by being polyimide resin which has the configuration unit expressed with a general formula (1).

[0008]

[Formula 2]



Among a formula, in R1 and R2, aliphatic series machine **** of bivalence expresses an aromatic series radical, the aliphatic series radical of tetravalence [8 / the aliphatic series radical of monovalence or an aromatic series radical, and / R7 and R8 / 6 / R3, R4, R5, and / R], or an aromatic series radical, R9 expresses the aliphatic series or the aromatic series radical of bivalence with carbon numbers 1-4, k is the integer of 5-50 and m:n is 5-80:95-20.

[0009] It is said semiconductor device with which R9 is preferably characterized by being diamino diphenyl ether residue or phenylenediamine residue in the configuration unit as which R7 and/or R8 are said semiconductor devices characterized by being biphenyl tetracarboxylic acid residue or pyromellitic acid residue preferably, and are expressed in a general formula (1) in the configuration unit expressed with a general formula (1).

[0010] Furthermore, as for this invention, the passivation film and the metal post for component electrodes of a semiconductor device were formed. On the semiconductor device front face on a wafer, the tension elastic modulus after imide-izing 2000 or less MPas, Coefficient of linear expansion is 200 ppm/degree C or less, and glass transition temperature is 200 degrees C or more. It heat-treats to the semiconductor device on the process which heats and sticks the polyamic acid film of a semi-hardening condition by pressure, and the wafer with which said polyamic acid film was stuck by pressure. The process at which said metal post front face is exposed after completing imide-ization, It is the manufacture approach of the semiconductor device characterized by consisting the process which makes a metal bump form in said exposed metal post front face, and the wafer in which said metal bump was formed of rear-face polish and a process which carries out dicing.

[0011]

[Embodiment of the Invention] Generally, since the polyimide film with a low coefficient of linear expansion with a high glass transition temperature was difficult to have and carry out the fabricating operation of the softening temperature since it has structure upright as a molecule frame, although it was excellent in dependability, using was difficult for it. On the other hand, this invention is using the film of the polyamic acid which is the precursor of polyimide with specific structure, workability can be given, after the formation of deer imide has a high glass transition temperature, coefficient of linear expansion is low as compared with conventional polyimide, dependability and thermal resistance are excellent, and it comes to complete this invention paying attention to moreover becoming flexible (an elastic modulus being low) polyimide.

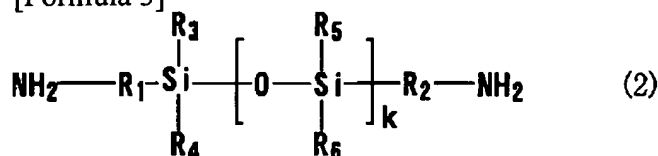
[0012] The polyamic acid used for this invention is usually obtained by making diamine and an acid anhydride react in a non-solvent or a solvent. As diamine, although diamino diphenyl ether and phenylenediamines are desirable, a diamino benzophenone, a benzidine, diamino diphenylmethane, diaminodiphenyl sulfone, etc. can be used. Moreover, as an acid anhydride, although pyromellitic acid 2 anhydride and biphenyl tetracarboxylic dianhydride are desirable, benzophenone tetracarboxylic dianhydride, trimellitic anhydride, etc. can be used and said diamine and acid anhydride can be used, respectively, combining suitably one sort or two sorts or more.

[0013] moreover, the siloxane compound expressed with a general formula (2) as one of the diamine components in order to make below into the fixed range the modulus of elasticity of the polyimide resin obtained from said polyamic acid in this invention -- 5 - 80-mol% of a diamine component total amount -- using together is more desirable. If fewer than five-mol% of a diamine component total amount, there is no effectiveness in generally reducing a modulus of elasticity, and the reduction effectiveness of package curvature can seldom expect. moreover -- if 80-mol % is exceeded -- coefficient of linear expansion -- it may become large, about [that the curvature reduction effectiveness becomes imperfection] and glass transition temperature may also become low, and dependability may be spoiled

[0014] As a siloxane compound expressed with a general formula (2), alpha and omega-bis(3-aminopropyl) poly dimethylsiloxane (APPS) are desirable, and, specifically, the case where the values of k in a formula are 5-50 is especially desirable from the tension elastic modulus of the resin obtained, glass transition temperature, an adhesive property, and a heat-resistant point. These siloxane compounds can also use two or more kinds together as well as using one kind independently. Especially the thing for which the siloxane compound of k=8-30 is used has the greatly desirable effectiveness of reducing an elastic modulus without spoiling other properties, such as thermal resistance.

[0015]

[Formula 3]



Among a formula, aliphatic series machine **** of bivalence expresses an aromatic series radical, R3, R4, R5, and R6 express the aliphatic series radical or aromatic series radical of monovalence with carbon numbers 1-4 in R1 and R2, and k is the integer of 5-50.

[0016] However, the tension elastic modulus after imide-izing is 2000 or less MPas, and coefficient of linear expansion becomes in 200 ppm [degree C] /or less, and glass transition temperature becomes 200 degrees C or more, and if it is in the combination which does not spoil film physical properties, it will not be limited to the combination of these monomers.

[0017] Furthermore, to said polyamic acid, it is the range which does not spoil said film engine performance after imide-izing, and it is also possible to add various additives, such as a filler and other resin, simultaneously. Although it is necessary to choose the combination from which the tension elastic modulus after imide-izing is 2000 or less MPas, and coefficient of linear expansion becomes in 200 ppm [degree C] /or less, and glass transition temperature becomes 200 degrees C or more at this time, when using for a major-diameter wafer 8 inches or more, degree C of coefficient of linear expansion is more desirable in 100 ppm /or less. Although based also on the elastic modulus of resin, or the thickness of a wafer, if coefficient of linear expansion generally exceeds degree C in 200 ppm /, it will become it is large and remarkable curling [which is generated at the time of cooling after imide-izing] the difference of an expansion coefficient with a wafer, and the alignment in an after process etc. will become difficult. Since the silicon wafer whose coefficient of linear expansion is generally about 3 ppm/degree C as adherend is used in many cases, it is still more desirable to become [degree C] in these about 3 ppm /. Although it cannot be probably by resin system which is generally expressed by the general formula (1), the one where coefficient of linear expansion is larger 0 ppm /than degree C is desirable. Moreover, although it is necessary to choose the combination from which the tension modulus of elasticity of resin is set to 2000 or less MPas, when using a major-diameter wafer 8 inches or more, 1000 or less MPas are more desirable. Although based also on the coefficient of linear expansion of resin, or the thickness of a wafer, if a tension elastic modulus generally exceeds 2000MPa(s), the residual stress generated between wafers is large, the curl generated at the time of cooling after lamination will become remarkable, and alignment etc. will become difficult at an after process. on the other hand, in order to maintain the dependability of a package, the glass transition temperature of resin is so desirable that it is high, but when solder thermal resistance etc. is taken into consideration, 200 degrees C or more are the glass transition temperature of 250 degrees C or more more desirably -- it is desirable.

[0018] Although the polyamic acid film which is used for this invention and with which the tension elastic modulus after imide-izing is 2000 or less MPas, and coefficient of linear expansion becomes in 200 ppm [degree C] /or less, and glass transition temperature can become 200 degrees C or more is used with the gestalt generally formed on the mold releasing film, a mold releasing film may be exfoliated and used for it if needed. As a mold releasing film, plastic films, such as a polypropylene, polyester, and polyether ape phone, polyimide, and polyethylene, are mentioned.

[0019] It is well-known spreading means, such as a roll coater, a rotary coating machine, a knife coating machine, a doctor blade, and a flow coater, as the manufacture approach of a polyamic acid film with a mold releasing film, on a mold releasing film, after carrying out flow casting spreading, stoving of the polyamic acid solution can be carried out, and it can obtain by making the polyamic acid film of a semi-hardening condition form. Moreover, it is also possible by carrying out thermocompression bonding of the polyamic acid film planes if needed to make it rival and to consider as a polyamic acid film with thick thickness.

[0020] In this invention, 80-200 degrees C and 5 - 30 minutes are suitable as conditions in which dry a polyamic acid solution and the polyamic acid film of a semi-hardening condition is made to form. When [that temperature is lower than this] time amount is short, in case heating sticking by pressure is carried out with a wafer, a fluidity is large, exudation is large and the variation in film thickness also becomes large. Moreover, when [that temperature is higher than this] time amount is long, in case it is heated and stuck by pressure with conductive foil, a fluidity is too small, adhesion with a wafer and the resin embedding nature to a metal post fall, and generating of a void increases.

[0021] As the manufacture approach of the semiconductor device of this invention, first, after heating and sticking the polyamic acid film plane of a semi-hardening condition by pressure, a mold releasing film is exfoliated to the wafer with which the passivation film and the metal post for component electrodes of a semiconductor device were formed the whole mold releasing film in the polyamic acid film with a mold releasing film, and heating fully performs imide-ization to it. At this time, you may use in the condition of having exfoliated with the mold releasing film, by devising a cushion (sheet-like shock absorbing material). Moreover, it is also possible by piling up and sticking the polyamic acid film of several sheets to coincidence by pressure at this time to form the thick closure resin layer of thickness at once.

[0022] the rate of imide-izing in the polyamic acid film condition of a semi-hardening condition -- 10 - 50% -- it should wish -- it is 20 - 40%. When the rate of imide-izing uses about [that the remaining workability has the bad tuck nature of a film], and a film, rolling round at less than 10%, it becomes difficult to paste a mold releasing film tooth back after rolling up, and to isolate a film one sheet at a time. A melting property worsens, and even if it doubles and carries out thermocompression bonding of the polyamic acid side, it stops moreover, fully unifying, if imide-ization is performed exceeding 50%.

[0023] The thickness of the polyimide resin used as a closure layer has the object which protects a semiconductor device and secures the dependability as a package to desirable 10 micrometers or more. It leads [also spoil about / that curvature becomes remarkable in case of the thickness exceeding 300 micrometers although excelled in dependability or air bubbles are generated at the time of imide-izing /, and productivity, and / to a cost rise] on the other hand, and is not desirable.

[0024] As conditions which heat and stick polyamic acid films, and a polyamic acid film and a wafer by pressure In the case of a press format, in the case of a roll type laminator, for 70-200 degrees C, 0.5-9.8MPa, and 5 to 30 minutes 70-200-degree-C, 1 - 500 kg/cm, and 0.1-50m conditions for /are suitable, and it has [generating of volatile matter] carrying out at the temperature which is not not much high and is more desirable than the drying temperature of a polyamic acid film especially as temperature. If the ambient atmosphere made to rival at this time is a vacuum, since generating of a void is mitigable, it is more desirable.

[0025] Although the conditions of the formation of heating imide change with the presentation of resin, and thickness, generally they are heated to the temperature more than the glass transition temperature (Tg) of resin. in order to make it foaming of a resin layer not take place -- the need -- responding -- low - warm -- ** -- it is desirable to raise temperature and to heat-treat it gradually. It is desirable for the solvent volatilization in a resin solution and the condensation water volatilization accompanying imide-izing to take place simultaneously at this time, and to fix a wafer by a certain approach by the volumetric shrinkage of a resin layer, if needed, since a wafer may be deformed or damaged. Moreover, in order to prevent oxidation of a metal post or a wafer, heat-treating in an inactive ambient atmosphere is desirable.

[0026] Subsequently, although a polyimide closure resin front face is ground if needed and a metal post

front face is exposed after imide-izing when the metal post front face is covered with the residual of a resin coat, the approach of polish can also use dry processes, such as plasma besides mechanical polish, and laser. Next, after forming metal bumps, such as a solder ball, in the exposed metal post front face, rear-face polish of a wafer is given and dicing is carried out to the shape of a chip.

[0027] In addition, the tension modulus of elasticity of a polyimide film was measured according to the approach of ASTM-D882 about the film obtained by carrying out etching clearance of the copper foil, after forming a film on a copper foil glossy surface. Moreover, about glass transition temperature and coefficient of linear expansion (the range of 50-100 degrees C), it measured with 5-degree-C programming rate for /using the apparatus for thermomechanical analysis made from the SEIKO electronic industry (TMA/SS 120C) using the above-mentioned film.

[0028]

[Example] Hereafter, although an example explains this invention concretely, this invention is not limited at all by this.

[0029] (Synthetic example 1) In the four-lot flask equipped with desiccation nitrogen gas installation tubing, the condensator, the thermometer, and the agitator Put in only the amount from which the solid content rate in [all] a brewing raw material becomes 20% of the weight about the partially aromatic solvent of 80 % of the weight of anhydrous N-methyl-2-pyrrolidones, and 20 % of the weight of toluene, and nitrogen gas, stirring the inside of a sink system 0.7 mols of 4 and 4'-diamino diphenyl ether, alpha, and 0.3 mols (it sets to APPS and a general formula (2), and the average of k is 20) of omega-bis(3-aminopropyl) poly dimethyl disiloxane are supplied, and it stirs until it becomes homogeneity. Keeping a system at 20 degrees C, after dissolving in homogeneity, it added gradually, 4 and 1.0 mols (BPDA) of 4'-biphenyl tetracarboxylic dianhydride it for 15 minutes with the shape of powder, churning was continued after that for 8 hours, and the polyamic acid solution A was obtained. [3, 3', and] The flask was kept at 20 degrees C in the meantime.

[0030] After having applied directly using this polyamic acid solution A so that the thickness after imide-izing might be set to 25 micrometers on a copper foil glossy surface, carrying out at 200 degrees C by 100 degrees C and carrying out [for 30 minutes] stoving at 300 degrees C by 250 degrees C for 30 minutes for 30 minutes for 30 minutes, it removed by carrying out overall etching of the copper foil, and the polyimide film was obtained. When the physical properties of the obtained film were measured, the tension elastic modulus was [140 ppm / degree C / and the glass transition temperature of 720MPa(s) and coefficient of linear expansion] 216 degrees C.

[0031] (Synthetic example 2) In the four-lot flask equipped with desiccation nitrogen gas installation tubing, the condensator, the thermometer, and the agitator Put in only the amount from which the solid content rate in [all] a brewing raw material becomes 20% of the weight about the partially aromatic solvent of 80 % of the weight of anhydrous N-methyl-2-pyrrolidones, and 20 % of the weight of toluene, and nitrogen gas, stirring the inside of a sink system 0.6 mols of p-phenylene diamines, alpha, and 0.4 mols (it sets to APPS and a general formula (2), and the average of k is 20) of omega-bis(3-aminopropyl) poly dimethyl disiloxane are supplied, and it stirs until it becomes homogeneity. Keeping a system at 20 degrees C, after dissolving in homogeneity, it added gradually, having poured [pyromellitic acid 2 / 1.0-mol] it for 15 minutes with the shape of powder (PMDA), churning was continued after that for 8 hours, and the polyamic acid solution B was obtained. The flask was kept at 20 degrees C in the meantime.

[0032] After having applied directly using this polyamic acid solution B so that the thickness after imide-izing might be set to 25 micrometers on a copper foil glossy surface, carrying out at 200 degrees C by 100 degrees C and carrying out [for 30 minutes] stoving at 300 degrees C by 250 degrees C for 30 minutes for 30 minutes for 30 minutes, it removed by carrying out overall etching of the copper foil, and the polyimide film was obtained. When the physical properties of the obtained film were measured, the tension elastic modulus was [160 ppm / degree C / and the glass transition temperature of 680MPa(s) and coefficient of linear expansion] 208 degrees C.

[0033] (Synthetic example 3) In the four-lot flask equipped with desiccation nitrogen gas installation tubing, the condensator, the thermometer, and the agitator Put in only the amount from which the solid

content rate in [all] a brewing raw material becomes 20% of the weight about the partially aromatic solvent of 80 % of the weight of anhydrous N-methyl-2-pyrrolidones, and 20 % of the weight of toluene, and nitrogen gas, stirring the inside of a sink system 0.50 mols (APB) of 0.50 mol [of 2 and 2-bis(4-(4-amino phenoxy) phenyl) propanes] (BAPP), 1, and 3-bis(3-amino phenoxy) benzene are thrown in, and it stirs until it becomes homogeneity. Keeping a system at 20 degrees C, after dissolving in homogeneity, it added gradually, having 0.7 mol [of - biphenyl tetracarboxylic dianhydride] (BPDA), 3, 3', and 4 and 4' 4, 4'-benzophenone poured [3, 3', and / 0.3-mol] them for 15 minutes with the shape of powder (BTDA), and churning was continued after that for 8 hours. The flask was kept at 20 degrees C in the meantime.

[0034] Then, nitrogen gas installation tubing and a condensator were removed, the flask was equipped with Dean Stark tubing which filled toluene, it replaced with the oil bath, the system was heated at 175 degrees C, and the generated water was removed out of the system. When it heats for 6 hours, generating of the water from a system is no longer accepted. The polyimide solution C was obtained by cooling a system. It was operated like the synthetic example 1 using this polyimide solution B, and the polyimide film was obtained. When the tension elastic modulus of the obtained film was measured, 60 ppm [degree C] /and the glass transition temperature of 3400MPa and coefficient of linear expansion were 220 degrees C.

[0035] (Example 1) On the commercial mold releasing film (YUPI REXX 75S: Ube Industries, Ltd. make), by the roll coater, this polyamic acid solution A was applied so that the thickness after imide-izing might be set to 25 micrometers, by 200 degrees C, it performed at 250 degrees C for 15 minutes for 15 minutes, 150 degrees C performed [110 degrees C] desiccation at 300 degrees C for 15 minutes for 15 minutes, and the thermoplastic polyimide film which the mold releasing film attached was obtained. Superposition and the vacuum press were used for the 8 inch silicon wafer with which the passivation film and the metal post for component electrodes of a semiconductor device were formed for the thermoplastic polyimide film side, and 350 degrees C, 2.0MPa, and 15-minute heating and sticking by pressure were performed under reduced pressure. After cooling to a room temperature, when the mold releasing film was removed, the wafer was put on the smooth side and the difference of the height of the highest point and the minimum point was measured, it is 20 micrometers and a wafer with a sealing agent with little curl, and the backward activity described below was able to be done duly. That is, after forming a solder ball in the metal post front face which ground the polyimide closure resin front face mechanically, was made to expose a metal post front face, and was exposed, rear-face polish of a wafer was given and the CSP type semiconductor device was obtained by carrying out dicing to the shape of a chip.

[0036] (Example 2) On the commercial mold releasing film (YUPI REXX 75S), by the roll coater, Solution A was applied so that the thickness after imide-izing might be set to 40 micrometers, by 200 degrees C, it performed at 250 degrees C for 15 minutes for 15 minutes, 150 degrees C performed [110 degrees C] desiccation at 300 degrees C for 30 minutes for 15 minutes for 15 minutes, and the thermoplastic polyimide film which the mold releasing film attached was obtained. After performing heating and sticking by pressure by part for 400-degree-C, 100 kg/cm, and 0.5m/and considering as a thermoplastic polyimide laminated film using a superposition and roll-type laminator so that thermoplastic polyimide film sides may face each other using the obtained thermoplasticity polyimide film with a mold releasing film, the mold releasing film of one side was exfoliated, and two thermoplastic polyimide films with which the mold releasing film stuck to one side were obtained.

[0037] Next, 350 degrees C, 2.0MPa, and 30-minute heating and sticking by pressure were performed for two thermoplastic polyimide films which exfoliated from the mold releasing film to the 8 inch silicon wafer with which the passivation film and the metal post for component electrodes of a semiconductor device were formed under reduced pressure using superposition and the vacuum press. When the mold releasing film was removed, the wafer was put on the smooth side after cooling and the difference of the height of the highest point and the minimum point was measured, it is 50 micrometers and a wafer with a sealing agent with little curl, and the backward activity described below was able to be done duly. That is, after forming a solder ball in the metal post front face which ground the polyimide

closure resin front face mechanically, was made to expose a metal post front face, and was exposed, rear-face polish of a wafer was given and the CSP type semiconductor device was obtained by carrying out dicing to the shape of a chip.

[0038] (Example 3) On the commercial mold releasing film (YUPI REXX 75S: Ube Industries, Ltd. make), by the roll coater, this polyamic acid solution B was applied so that the thickness after imide-izing might be set to 25 micrometers, by 200 degrees C, it performed at 250 degrees C for 15 minutes for 15 minutes, 150 degrees C performed [110 degrees C] desiccation at 300 degrees C for 15 minutes for 15 minutes, and the thermoplastic polyimide film which the mold releasing film attached was obtained. Superposition and the vacuum press were used for the 8 inch silicon wafer with which the passivation film and the metal post for component electrodes of a semiconductor device were formed for the thermoplastic polyimide film side, and 350 degrees C, 2.0MPa, and 15-minute heating and sticking by pressure were performed under reduced pressure. After cooling to a room temperature, when the mold releasing film was removed, the wafer was put on the smooth side and the difference of the height of the highest point and the minimum point was measured, it is 30 micrometers and a wafer with a sealing agent with little curl, and the backward activity described below was able to be done duly. That is, after forming a solder ball in the metal post front face which ground the polyimide closure resin front face mechanically, was made to expose a metal post front face, and was exposed, rear-face polish of a wafer was given and the CSP type semiconductor device was obtained by carrying out dicing to the shape of a chip.

[0039] (Example 1 of a comparison) The thermoplastic polyimide film which 40-micrometer mold releasing film attached using the same resin and same approach as an example 2 was obtained. In order to make 25 things which exfoliated the mold releasing film of the obtained thermoplasticity polyimide film with a mold releasing film rival the 8 inch silicon wafer with which the passivation film and the metal post for component electrodes of a semiconductor device were formed by [as setting the thickness sum total to 1000 micrometers in piles], the vacuum press was used and 350 degrees C, 2.0MPa, and 30-minute heating and sticking by pressure were performed under reduced pressure. When the wafer was put on the smooth side after cooling, the difference of the height of the highest point and the minimum point was measured, it was 380 micrometers and a wafer with a sealing agent with big curl and a backward activity was done, trouble was not able to be caused to alignment etc. and an activity was not able to be done.

[0040] (Example 2 of a comparison) On the commercial mold releasing film (YUPI REXX 75S), by the roll coater, the polyimide solution C was applied so that the thickness after desiccation might be set to 25 micrometers, by 110 degrees C, it performed at 200 degrees C for 15 minutes for 15 minutes, 150 degrees C performed desiccation at 250 degrees C for 15 minutes for 15 minutes, and the thermoplastic polyimide film which the mold releasing film attached was obtained. Superposition and the vacuum press were used for the 8 inch silicon wafer with which the passivation film and the metal post for component electrodes of a semiconductor device were formed for the polyimide film side, and 280 degrees C, 3.9MPa, and 30-minute heating and sticking by pressure were performed under reduced pressure. Then, when the mold releasing film was removed, the wafer was put on the smooth side and the difference of the height of the highest point and the minimum point was measured, when it was 480 micrometers and a wafer with a sealing agent with big curl and a backward activity was done, trouble was not able to be caused to alignment etc., and an activity was not able to be done.

[0041]

[Effect of the Invention] It is the manufacture approach of a semiconductor device of the curvature of this invention after a resin seal having been small by using the thermoplastic polyimide film which an elastic modulus can process low and easily, could manufacture easily the wafer level CSP which was moreover excellent in dependability with sufficient productivity, and having excelled in the industrial target.

[Translation done.]

* NOTICES *

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

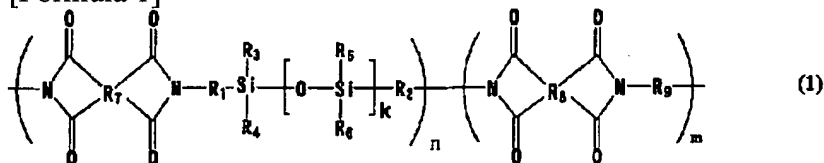
CLAIMS

[Claim(s)]

[Claim 1] The semiconductor device to which a tension elastic modulus is characterized by being formed by 10-300-micrometer thickness as a sealing agent layer on the semiconductor device passivation film with which the metal electrode was formed with the polyimide resin 200 ppm [degree C] /or less and whose glass transition temperature 2000 or less MPas and coefficient of linear expansion are 200 degrees C or more.

[Claim 2] The semiconductor device according to claim 1 with which a tension elastic modulus is characterized by being polyimide resin with which 2000 or less MPas and coefficient of linear expansion have the configuration unit as which the polyimide resin 200 ppm [degree C] /or less and whose glass transition temperature are 200 degrees C or more is expressed in a general formula (1).

[Formula 1]



In the aliphatic series radical of bivalence or an aromatic series radical, and R3, R4, R5 and R6, R1 and R2 express the aliphatic series radical of monovalence or an aromatic series radical, the aliphatic series radical of tetravalence [8 / R7 and / R], or an aromatic series radical with carbon numbers 1-4 among a formula, R9 expresses the aliphatic series or the aromatic series radical of bivalence, k is the integer of 5-50 and m:n is 5-80:95-20.

[Claim 3] The semiconductor device according to claim 2 with which R7 and/or R8 are characterized by being biphenyl tetracarboxylic acid residue in the configuration unit expressed with a general formula (1).

[Claim 4] The semiconductor device according to claim 2 with which R7 and/or R8 are characterized by being pyromellitic acid residue in the configuration unit expressed with a general formula (1).

[Claim 5] The semiconductor device according to claim 2 to 4 with which R9 is characterized by being diamino diphenyl ether residue in the configuration unit expressed with a general formula (1).

[Claim 6] The semiconductor device according to claim 2 to 4 with which R9 is characterized by being phenylenediamine residue in the configuration unit expressed with a general formula (1).

[Claim 7] The passivation film and the metal post for component electrodes of a semiconductor device were formed. On the semiconductor device front face on a wafer, the tension elastic modulus after imide-izing 2000 or less MPas, Coefficient of linear expansion is 200 ppm/degree C or less, and glass transition temperature is 200 degrees C or more. It heat-treats to the semiconductor device on the process which heats and sticks the polyamic acid film of a semi-hardening condition by pressure, and the wafer with which said polyamic acid film was stuck by pressure. The manufacture approach of the semiconductor device characterized by consisting the process at which said metal post front face is exposed, the process which makes a metal bump form in said exposed metal post front face, and the

wafer in which said metal bump was formed of rear-face polish and a process which carries out dicing after completing imide-ization.

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最終頁に続く

(54) 【発明の名称】 半導体装置及びその製造方法

(57) 【要約】

【課題】 樹脂封止後の反りが小さく、信頼性と耐熱性に優れたウエハーレベルパッケージ方式によるCSPを、容易に生産性良く製造することのできる、半導体装置の製造方法を提供する。

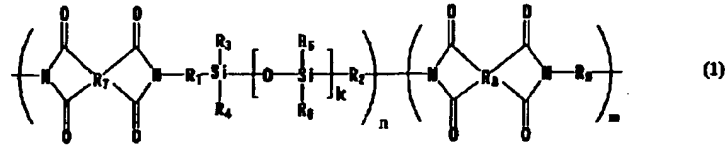
【解決手段】 バッシベーション膜および半導体素子の素子電極用メタルポストが形成された、ウエハー状の半導体素子表面に、イミド化後の引張り弾性率が2000MPa以下で且つ線膨張係数が200ppm/℃以下、ガラス転移温度が200℃以上である、半硬化状態のポリアミック酸フィルムを加熱・圧着する工程、このポリアミック酸フィルムの形成されたウエハー状の半導体素子に熱処理を施して、イミド化を完結した後に、必要に応じてポリイミド封止材表面を研磨して、メタルポスト表面を露出させる工程、露出したメタルポスト表面に金属バンプを形成させる工程、金属バンプを形成したウエハーを裏面研磨およびダイシングする工程、を経て、半導体装置を製造する。

【特許請求の範囲】

【請求項1】 金属電極の形成された半導体素子パッシベーション膜上に、封止材層として、引張り弾性率が2000MPa以下、線膨張係数が200ppm/℃以下、且つ、ガラス転移温度が200℃以上であるポリイミド樹脂により、10～300μmの膜厚で形成されていることを特徴とする半導体装置。

*【請求項2】 引張り弾性率が2000MPa以下、線膨張係数が200ppm/℃以下、且つ、ガラス転移温度が200℃以上であるポリイミド樹脂が、一般式(1)で表される構成単位を有するポリイミド樹脂であることを特徴とする、請求項1記載の半導体装置。

【化1】



式中、R₁、R₂は炭素数1～4で二価の脂肪族基又は芳香族基、R₃、R₄、R₅、及びR₆は一価の脂肪族基又は芳香族基、R₇、R₈は四価の脂肪族基又は芳香族基、R₉は二価の脂肪族又は芳香族基を表し、kは5～50の整数、m：nは5～80：95～20である。

【請求項3】 一般式(1)で表される構成単位においてR₇及び／又はR₈が、ビフェニルテトラカルボン酸残基であることを特徴とする、請求項2記載の半導体装置。

【請求項4】 一般式(1)で表される構成単位においてR₇及び／又はR₈が、ピロメリット酸残基であることを特徴とする、請求項2記載の半導体装置。

【請求項5】 一般式(1)で表される構成単位においてR₉が、ジアミノジフェニルエーテル残基であることを特徴とする、請求項2～4のいずれかに記載の半導体装置。

【請求項6】 一般式(1)で表される構成単位においてR₉が、フェニレンジアミン残基であることを特徴とする、請求項2～4のいずれかに記載の半導体装置。

【請求項7】 パッシベーション膜及び半導体素子の素子電極用メタルポストが形成された、ウエハー上の半導体素子表面に、イミド化後の引張り弾性率が2000MPa以下、線膨張係数が200ppm/℃以下、且つ、ガラス転移温度が200℃以上である、半硬化状態のポリアミック酸フィルムを加熱・圧着する工程、前記ポリアミック酸フィルムが圧着されたウエハー上の半導体素子に熱処理を施して、イミド化を完結した後に、前記メタルポスト表面を露出させる工程、前記露出させたメタルポスト表面に金属バンプを形成させる工程、前記金属バンプを形成したウエハーを裏面研磨及びダイシングする工程、とからなることを特徴とする半導体装置の製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、半導体素子の集積回路部を保護し、且つ、半導体素子と外部装置との電気的接続安定性に優れ、高密度実装を可能とした半導体装置、特にチップスケールパッケージ(CSP)、及びそ

※の製造方法に関するものである。

【0002】

【従来の技術】従来、CSPの製造方式としては、ウエハー上に作製された半導体集積回路装置(IC)を、個々のチップに切断してから、バンプ電極の取り付けやIC表面保護の樹脂封止を行っていた。これに対して、近年、ウエハーレベルで一括して封止成形する、ウエハーレベルパッケージ方式が、注目され始めている。

【0003】このウエハーレベルパッケージ方式によるCSPは、通常、パッシベーション膜及び半導体素子の素子電極用メタルポストが形成された、ウエハー状の半導体素子表面に、コンプレッション成形やトランスファー成形によって、エポキシ樹脂系封止材を形成した後、必要に応じてポリイミド封止材表面を研磨して、メタルポスト表面を露出させる工程、露出したメタルポスト表面に金属バンプを形成させる工程、前記金属バンプを形成したウエハーを裏面研磨及びダイシングする工程、をとることにより製造されている。

【0004】しかし、このような方法で製造されたパッケージは、封止樹脂とシリコンウエハーとの線膨張係数の差に起因して、樹脂封止後に反りが発生するが、特に8インチ以上の大きな径のウエハーでは、反りが顕著になり、後工程が困難となり製造上大きな問題となっている。

【0005】

【発明が解決しようとする課題】本発明は、樹脂封止後のパッケージの反りが小さく、しかも信頼性に優れるウエハーレベルパッケージ方式による、半導体装置及びその製造方法を提供することにある。

【0006】

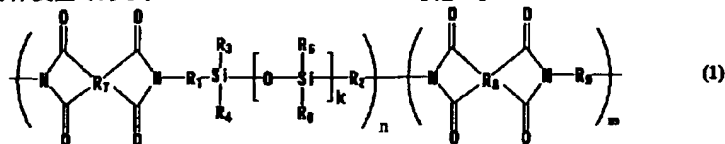
【課題を解決するための手段】即ち、本発明は、金属電極の形成された半導体素子パッシベーション膜上に、封止材層として、引張り弾性率が2000MPa以下、線膨張係数が200ppm/℃以下、且つ、ガラス転移温度が200℃以上であるポリイミド樹脂により、10～300μmの膜厚で形成されていることを特徴とする半導体装置である。

【0007】また、ポリイミド樹脂が、一般式(1)で

表される構成単位を有するポリイミド樹脂であることを特徴とする、前記半導体装置である。

*【0008】

*【化2】



式中、R₁、R₂は炭素数1～4で二価の脂肪族基または芳香族基、R₃、R₄、R₅、及びR₆は一価の脂肪族基又は芳香族基、R₇、R₈は四価の脂肪族基又は芳香族基、R₉は二価の脂肪族又は芳香族基を表し、kは5～50の整数、m：nは5～80：95～20である。

【0009】一般式(1)で表される構成単位においてR₇及び/又はR₈が、好ましくは、ビフェニルテトラカルボン酸残基、又は、ピロメリット酸残基であることを特徴とする前記半導体装置であり、一般式(1)で表される構成単位においてR₉が、好ましくは、ジアミノジフェニルエーテル残基、又は、フェニレンジアミン残基であることを特徴とする、前記半導体装置である。

【0010】更に、本発明は、パッシベーション膜及び半導体素子の素子電極用メタルポストが形成された、ウエハー上の半導体素子表面に、イミド化後の引張り弾性率が2000MPa以下、線膨張係数が200ppm/℃以下、且つ、ガラス転移温度が200℃以上である、半硬化状態のポリアミック酸フィルムを加熱・圧着する工程、前記ポリアミック酸フィルムが圧着されたウエハー上の半導体素子に熱処理を施して、イミド化を完結した後に、前記メタルポスト表面を露出させる工程、前記露出させたメタルポスト表面に金属バンプを形成させる工程、前記金属バンプを形成したウエハーを裏面研磨及びダイシングする工程、とからなることを特徴とする半導体装置の製造方法である。

【0011】

【発明の実施の形態】一般にガラス転移温度が高く線膨張係数が低いポリイミドフィルムは、分子骨格として剛直な構造を持つため軟化点を持たず、成形加工することが困難であるために、信頼性に優れるにもかかわらず、利用することが難しかった。一方、本発明は、特定の構造を持つポリイミドの前駆体であるポリアミック酸のフィルムを利用することで、加工性を付与でき、しかイミド化後は、ガラス転移温度が高く、線膨張係数が従来のポリイミドと比較し低く、信頼性・耐熱性が優れ、しかも柔軟(弾性率が低い)なポリイミドとなることに着目※

※し、本発明を完成するに至ったものである。

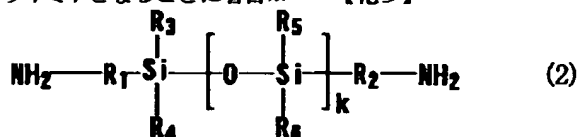
【0012】本発明に用いるポリアミック酸は、通常、ジアミンと酸無水物とを、無溶媒又は溶媒中で反応させることにより得られる。ジアミンとしては、ジアミノジフェニルエーテル類、フェニレンジアミン類が好ましいが、ジアミノベンゾフェノン、ベンジジン、ジアミノジフェニルメタン、ジアミノジフェニルスルホンなども用いることが出来る。また、酸無水物としては、ピロメリット酸二無水物、ビフェニルテトラカルボン酸二無水物類が好ましいが、ベンゾフェノンテトラカルボン酸二無水物、トリメリット酸無水物なども使用することができ、前記ジアミン及び酸無水物は、それぞれ1種又は2種以上を適宜組み合わせる用いることができる。

【0013】また、本発明において、前記ポリアミック酸より得られるポリイミド樹脂の弾性率を一定範囲以下にするため、ジアミン成分の一つとして、一般式(2)で表わされるシロキサン化合物を、ジアミン成分総量の5～80モル%併用することが、より好ましい。ジアミン成分総量の5モル%より少ないと、一般的に弾性率を低下させるのに効果がなく、パッケージ反りの低減効果があまり期待できない。また、80モル%を越えると、線膨張係数大きくなり、反り低減効果が不十分になるばかりか、ガラス転移温度も低くなり、信頼性を損なうことがある。

【0014】一般式(2)で表されるシロキサン化合物として、具体的には、α,ω-ビス(3-アミノプロピル)ポリジメチルシロキサン(APPS)が好ましく、特に式中のkの値が5～50の場合が、得られる樹脂の引張り弾性率、ガラス転移温度、接着性、耐熱性の点から好ましい。これらのシロキサン化合物は、1種類のみ単独で用いることは勿論、2種類以上を併用することもできる。特に、k=8～30のシロキサン化合物を用いることは、耐熱性等他の特性を損なわないで弾性率を低下させる効果が大きく好ましい。

【0015】

【化3】



式中、R₁、R₂は炭素数1～4で二価の脂肪族基または芳香族基、R₃、R₄、R₅、及びR₆は一価の脂肪族基又は★50

★は芳香族基を表し、kは5～50の整数である。

【0016】但し、イミド化後の引張り弾性率が200

0MPa以下で且つ線膨張係数が200ppm/℃以下、ガラス転移温度が200℃以上となり、フィルム物性を損なわない組み合わせで有れば、これらのモノマーの組み合わせに限定されるものではない。

【0017】更に、前記ポリアミク酸には、イミド化後の前記フィルム性能を損なわない範囲で、フィラーや他の樹脂等各種添加剤を同時に添加することも可能である。このとき、イミド化後の引張り弾性率が2000MPa以下で且つ線膨張係数が200ppm/℃以下、ガラス転移温度が200℃以上となる組み合わせを選択する必要があるが、8インチ以上の大径ウエハーに用いる場合は、線膨張係数は100ppm/℃以下が、より好ましい。樹脂の弾性率やウエハーの厚みにもよるが、一般に線膨張係数が200ppm/℃を超えると、ウエハーとの膨張係数の差が大きく、イミド化後の冷却時に発生するカールが顕著となり、後工程における位置合わせ等が困難となる。被着体としては一般に線膨張係数が3ppm/℃程度のシリコンウエハーを用いることが多いので、この3ppm/℃程度になるのが更に好ましい。一般に一般式(1)で表現されるような樹脂系ではまずあり得ないが、線膨張係数が0ppm/℃より大きい方が好ましい。また樹脂の引張り弾性率が2000MPa以下となる組み合わせを選択する必要があるが、8インチ以上の大径ウエハーを用いる場合は、1000MPa以下がより好ましい。樹脂の線膨張係数やウエハーの厚みにもよるが、一般に引張り弾性率が2000MPaを超えると、ウエハーとの間に発生する残留応力が大きく、張り合わせ後の冷却時に発生するカールが顕著となり、後工程で位置合わせ等が困難となる。一方、パッケージの信頼性を保つためには樹脂のガラス転移温度は高いほど好ましいが、半田耐熱性等を考慮すると200℃以上、より望ましくは250℃以上のガラス転移温度であること好ましい。

【0018】本発明に用いる、イミド化後の引張り弾性率が2000MPa以下で且つ線膨張係数が200ppm/℃以下、ガラス転移温度が200℃以上となり得るポリアミク酸フィルムは、一般に離型フィルム上に形成された形態で利用されるが、必要に応じて離型フィルムを剥離して用いても構わない。離型フィルムとしては、ポリプロピレン、ポリエステル、ポリエーテルサルフォン、ポリイミド、ポリエチレン等のプラスチックフィルムが挙げられる。

【0019】離型フィルム付きのポリアミク酸フィルムの製造方法としては、ポリアミク酸溶液を離型フィルム上に、ロールコーター、ロータリーコーター、ナイフコーター、ドクターブレード、フローコーター等の公知の塗布手段で、流延塗布した後、加熱乾燥して、半硬化状態のポリアミク酸フィルムを形成させることにより得ることが出来る。また、必要に応じてポリアミク酸フィルム面同士を熱圧着することにより、張り合わせ

て厚みの厚いポリアミク酸フィルムとすることも可能である。

【0020】本発明において、ポリアミク酸溶液を乾燥させ、半硬化状態のポリアミク酸フィルムを形成させる条件としては、80～200℃、5～30分が適当である。これより温度が低く時間が短い場合、ウエハーと加熱圧着する際、流動性が大きく、しみ出しが大きく、フィルム厚のバラツキも大きくなる。また、これより温度が高く時間が長い場合は、導体箔と加熱・圧着する際、流動性が小さすぎ、ウエハーとの密着性やメタルポストへの樹脂埋め込み性が低下し、ボイドの発生が多くなる。

【0021】本発明の半導体装置の製造方法としては、まず、離型フィルム付きポリアミク酸フィルムを、離型フィルムごとパッシベーション膜及び半導体素子の素子電極用メタルポストが形成されたウエハーに、半硬化状態のポリアミク酸フィルム面を加熱・圧着した後、離型フィルムを剥離し、加熱により十分にイミド化を行なう。この時、クッション(シート状の緩衝材)を工夫することにより、離型フィルムと剥離した状態で利用しても構わない。また、このとき同時に数枚のポリアミク酸フィルムを重ね合わせて圧着することにより、厚みの厚い封止樹脂層を、一度に形成することも可能である。

【0022】半硬化状態のポリアミク酸フィルム状態におけるイミド化率は、10～50%、望むべくは20～40%である。イミド化率が10%未満では、フィルムのタック性が残り作業性が悪いばかりか、フィルムを巻取って使用する場合、巻き取り後に離型フィルム背面に接着して、フィルムを一枚ずつ単離することが難しくなる。また、50%を超えてイミド化を施すと、溶融特性が悪くなり、ポリアミク酸面を合わせて熱圧着しても、充分に一体化しなくなる。

【0023】封止層として用いるポリイミド樹脂の厚みは、半導体素子を保護しパッケージとしての信頼性を確保する目的から、10μm以上が望ましい。一方、300μmを超える厚みだと、信頼性には優れるものの反りが顕著となったり、イミド化時に気泡が発生するばかりか、生産性も損ないコストアップにもつながり好ましくない。

【0024】ポリアミク酸フィルム同士、及びポリアミク酸フィルムとウエハーとを加熱・圧着する条件としては、プレス形式の場合は、70～200℃、0.5～9.8MPa、5～30分、ロール式ラミネータの場合は、70～200℃、1～500kg/cm、0.1～50m/分の条件が適当であり、特に温度としては、ポリアミク酸フィルムの乾燥温度より、あまり高くない温度で実施するのが、揮発物の発生もなく望ましい。このとき張り合わせる雰囲気は真空になっていると、ボイドの発生が軽減できるのでより好ましい。

【0025】加熱イミド化の条件は、樹脂の組成、厚みにより異なるが、一般に樹脂のガラス転移温度(T_g)以上の温度に加熱する。樹脂層の発泡が起こらないようにするため、必要に応じて低温から徐々に温度を上昇させて熱処理することが好ましい。このとき、樹脂溶液中の溶剤揮発とイミド化に伴う縮合水揮発が同時に起こり、樹脂層の体積収縮により、ウエハーが変形もしくは破損することがあるため、必要に応じて何らかの方法で、ウエハーを固定することが好ましい。また、メタルポストやウエハーの酸化を防ぐために、不活性な雰囲気

10 で熱処理することが好ましい。
【0026】次いで、イミド化後に、樹脂皮膜の残留によりメタルポスト表面が覆われている場合は、必要に応じてポリイミド封止樹脂表面を研磨して、メタルポスト表面を露出させるが、研磨の方法は、機械的な研磨の他、プラズマ、レーザー等のドライプロセスを用いることも可能である。次に、露出したメタルポスト表面に、半田ボール等の金属パンパを形成した後、ウエハーの裏面研磨を施し、チップ状にダイシングする。

【0027】尚、ポリイミドフィルムの引張り弾性率は、銅箔光沢面上にフィルムを形成した後、銅箔をエッチング除去して得られるフィルムについて、ASTM-D882の方法に従って測定した。またガラス転移温度および線膨張係数(50~100℃の範囲)に関しては上述のフィルムを用いてセイコー電子工業製熱機械分析装置(TMA/SS 120C)を用いて5℃/分の昇温速度にて測定した。

【0028】

【実施例】以下、実施例により本発明を具体的に説明するが、本発明はこれによって何ら限定されるものではない。

【0029】(合成例1)乾燥窒素ガス導入管、冷却器、温度計、攪拌機を備えた四口フラスコに、無水のN-メチル-2-ピロリドン80重量%とトルエン20重量%の混合溶剤を、全仕込原料中の固形分割合が20重量%になるだけの量を入れ、窒素ガスを流し系中をかき混ぜながら、4,4'-ジアミノジフェニルエーテル0.7モル、および α,ω -ビス(3-アミノプロピル)ポリジメチルジシロキサン(PPS、一般式(2)においてkの平均値が20)0.3モルを投入し、均一になるまでかき混ぜる。均一に溶解した後、系を20℃に保ちながら、3,3',4,4'-ビフェニルテトラカルボン酸二無水物(BPDA)1.0モルを、粉末状のまま15分間かけて徐々に添加し、その後8時間攪拌を続けポリアミック酸溶液Aを得た。この間フラスコは20℃に保った。

【0030】このポリアミック酸溶液Aを用いて、銅箔光沢面上にイミド化後の厚みが25 μ mとなるように直接塗布し、100℃で30分、200℃で30分、250℃で30分、300℃で30分加熱乾燥した後、銅箔

を全面エッチングすることにより除去して、ポリイミドフィルムを得た。得られたフィルムの物性を測定したところ引張り弾性率は720MPa、線膨張係数は140ppm/℃、ガラス転移温度は216℃であった。

【0031】(合成例2)乾燥窒素ガス導入管、冷却器、温度計、攪拌機を備えた四口フラスコに、無水のN-メチル-2-ピロリドン80重量%とトルエン20重量%の混合溶剤を、全仕込原料中の固形分割合が20重量%になるだけの量を入れ、窒素ガスを流し系中をかき混ぜながら、p-フェニレンジアミン0.6モル、および α,ω -ビス(3-アミノプロピル)ポリジメチルジシロキサン(PPS、一般式(2)においてkの平均値が20)0.4モルを投入し、均一になるまでかき混ぜる。均一に溶解した後、系を20℃に保ちながら、ピロメリット酸二無水物(PMDA)1.0モルを、粉末状のまま15分間かけて徐々に添加し、その後8時間攪拌を続けポリアミック酸溶液Bを得た。この間フラスコは20℃に保った。

【0032】このポリアミック酸溶液Bを用いて、銅箔光沢面上にイミド化後の厚みが25 μ mとなるように直接塗布し、100℃で30分、200℃で30分、250℃で30分、300℃で30分加熱乾燥した後、銅箔を全面エッチングすることにより除去して、ポリイミドフィルムを得た。得られたフィルムの物性を測定したところ引張り弾性率は680MPa、線膨張係数は160ppm/℃、ガラス転移温度は208℃であった。

【0033】(合成例3)乾燥窒素ガス導入管、冷却器、温度計、攪拌機を備えた四口フラスコに、無水のN-メチル-2-ピロリドン80重量%とトルエン20重量%の混合溶剤を、全仕込原料中の固形分割合が20重量%になるだけの量を入れ、窒素ガスを流し系中をかき混ぜながら、2,2-ビス(4-(4-アミノフェノキシ)フェニル)プロパン(BAPP)0.50モル、および1,3-ビス(3-アミノフェノキシ)ベンゼン(APB)0.50モルを投入し、均一になるまでかき混ぜる。均一に溶解した後、系を20℃に保ちながら、3,3',4,4'-ビフェニルテトラカルボン酸二無水物(BPDA)0.7モル、および3,3',4,4'-ベンゾフェノンテトラカルボン酸二無水物(BTDA)0.3モルを、粉末状のまま15分間かけて徐々に添加し、その後8時間攪拌を続けた。この間フラスコは20℃に保った。

【0034】その後、窒素ガス導入管と冷却器を外し、トルエンを満たしたディーン・スターク管をフラスコに装着し、油浴に代えて系を175℃に加熱し、発生する水を系外に除いた。6時間加熱したところ、系からの水の発生は認められなくなった。系を冷却することによりポリイミド溶液Cが得られた。このポリイミド溶液Bを用いて合成例1と同様に操作してポリイミドフィルムを得た。得られたフィルムの引張り弾性率を測定したとこ

ろ、3400MPa、線膨張係数は60ppm/℃、ガラス転移温度は220℃であった。

【0035】(実施例1)市販の離型フィルム(ユービレックス75S:宇部興産社製)上に、このポリアミク酸溶液Aをロールコーターで、イミド化後の厚みが25μmになるように塗布し、110℃で15分、150℃で15分、200℃で15分、250℃で15分、300℃で15分乾燥を行ない、離型フィルムのついた熱可塑性ポリイミドフィルムを得た。パッシベーション膜および半導体素子の素子電極用メタルポストが形成された、8インチシリコンウエハーに熱可塑性ポリイミドフィルム面を重ね合わせ、真空プレスを用いて減圧下で350℃、2.0MPa、15分加熱・圧着を行なった。室温に冷却した後、離型フィルムを剥しウエハーを平滑面に置いて、最高地点と最低地点の高さの差を測ったところ、20μmとカールの少ない封止材付きウエハーとなっており、以下に述べる後作業を滞りなく行なうことができた。即ち、ポリイミド封止樹脂表面を機械的に研磨してメタルポスト表面を露出させ、露出したメタルポスト表面に半田ボールを形成した後、ウエハーの裏面研磨を施し、チップ状にダイシングすることによりCSPタイプの半導体装置を得た。

【0036】(実施例2)市販の離型フィルム(ユービレックス75S)上に、溶液Aをロールコーターで、イミド化後の厚みが40μmになるように塗布し、110℃で15分、150℃で15分、200℃で15分、250℃で15分、300℃で30分乾燥を行ない、離型フィルムのついた熱可塑性ポリイミドフィルムを得た。得られた離型フィルム付き熱可塑性ポリイミドフィルムを2枚用いて、熱可塑性ポリイミドフィルム同士が向かい合うように重ね合わせ、ロール式のラミネータを用いて、400℃、100kg/cm、0.5m/分で加熱・圧着を行ない、熱可塑性ポリイミド積層フィルムとした後に、片側の離型フィルムを剥離し、片側に離型フィルムの付いた熱可塑性ポリイミドフィルムを得た。

【0037】次に、パッシベーション膜および半導体素子の素子電極用メタルポストが形成された、8インチシリコンウエハーに離型フィルムから剥離した熱可塑性ポリイミドフィルム2枚とを重ね合わせ、真空プレスを用いて減圧下で350℃、2.0MPa、30分加熱・圧着を行なった。冷却後、離型フィルムを剥しウエハーを平滑面に置いて、最高地点と最低地点の高さの差を測ったところ、50μmとカールの少ない封止材付きウエハーとなっており、以下に述べる後作業を滞りなく行なうことができた。即ち、ポリイミド封止樹脂表面を機械的に研磨して、メタルポスト表面を露出させ、露出したメタルポスト表面に半田ボールを形成した後、ウエハーの裏面研磨を施し、チップ状にダイシングすることによりCSPタイプの半導体装置を得た。

【0038】(実施例3)市販の離型フィルム(ユービ

レックス75S:宇部興産社製)上に、このポリアミク酸溶液Bをロールコーターで、イミド化後の厚みが25μmになるように塗布し、110℃で15分、150℃で15分、200℃で15分、250℃で15分、300℃で15分乾燥を行ない、離型フィルムのついた熱可塑性ポリイミドフィルムを得た。パッシベーション膜および半導体素子の素子電極用メタルポストが形成された、8インチシリコンウエハーに熱可塑性ポリイミドフィルム面を重ね合わせ、真空プレスを用いて減圧下で350℃、2.0MPa、15分加熱・圧着を行なった。室温に冷却した後、離型フィルムを剥しウエハーを平滑面に置いて、最高地点と最低地点の高さの差を測ったところ、30μmとカールの少ない封止材付きウエハーとなっており、以下に述べる後作業を滞りなく行なうことができた。即ち、ポリイミド封止樹脂表面を機械的に研磨してメタルポスト表面を露出させ、露出したメタルポスト表面に半田ボールを形成した後、ウエハーの裏面研磨を施し、チップ状にダイシングすることによりCSPタイプの半導体装置を得た。

【0039】(比較例1)実施例2と同様の樹脂および方法を用いて40μm離型フィルムのついた熱可塑性ポリイミドフィルムを得た。得られた離型フィルム付き熱可塑性ポリイミドフィルムの、離型フィルムを剥離したものを25枚重ねて、厚み合計が1000μmとなるようにして、パッシベーション膜および半導体素子の素子電極用メタルポストが形成された、8インチシリコンウエハーと張り合わせるために、真空プレスを用いて減圧下で、350℃、2.0MPa、30分加熱・圧着を行なった。冷却後、ウエハーを平滑面に置いて、最高地点と最低地点の高さの差を測ったところ、380μmとカールが大きな封止材付きウエハーとなっており、後作業を行なう際に、位置合わせ等に支障をきたし作業を進めることができなかった。

【0040】(比較例2)市販の離型フィルム(ユービレックス75S)上に、ポリイミド溶液Cをロールコーターで、乾燥後の厚みが25μmになるように塗布し、110℃で15分、150℃で15分、200℃で15分、250℃で15分乾燥を行ない、離型フィルムのついた熱可塑性ポリイミドフィルムを得た。パッシベーション膜および半導体素子の素子電極用メタルポストが形成された8インチシリコンウエハーに、ポリイミドフィルム面を重ね合わせ、真空プレスを用いて減圧下で、280℃、3.9MPa、30分加熱・圧着を行なった。この後、離型フィルムを剥しウエハーを平滑面に置いて、最高地点と最低地点の高さの差を測ったところ、480μmとカールが大きな封止材付きウエハーとなっており、後作業を行う際に位置合わせ等に支障をきたし、作業を進めることができなかった。

【0041】

【発明の効果】本発明は、弾性率が低く、かつ容易に加

工できる熱可塑性ポリイミドフィルムを利用することにより、樹脂封止後の反りが小さく、しかも信頼性に優れたウエハーレベルCSPを、容易に生産性良く製造する

ことができ、工業的に優れた半導体装置の製造方法である。

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